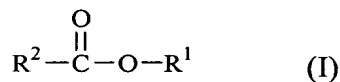
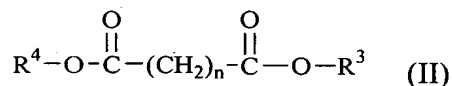


WHAT IS CLAIMED IS:

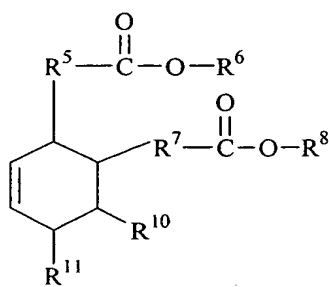
1. A vulcanized rubber composition comprising rubber selected from the group consisting of natural rubber, synthetic rubber, and a combination thereof; and a liquid adhesion promoter selected from the group consisting of a solution and a water-based emulsion containing (1) an adhesive resin in an amount of about 0.1% to about 15% by weight, based on the weight of rubber in the composition; (2) a vulcanizing agent for the rubber in an amount sufficient to vulcanize said rubber; (3) a reactive diluent in an amount of about 0.5% to about 50% by weight, based on the total weight of the adhesive resin plus ester of formula I - IV; and (4) an ester having formula I, II, III, IV or a combination of any two or more of said esters in an amount of about 0.1% to about 15% by weight, based on the weight of rubber in the composition:



wherein R^1 is a $\text{C}_3\text{-C}_{24}$ alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds; R^2 is a $\text{C}_3\text{-C}_{24}$ saturated fatty acid residue, or an unsaturated fatty acid residue having 1 to 6 carbon-to-carbon double bonds;



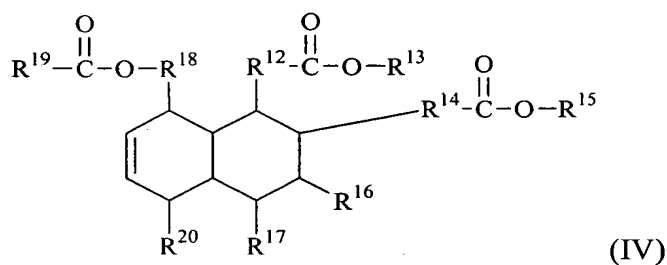
wherein $n=3\text{-}24$, and R^3 and R^4 , same or different, are a $\text{C}_3\text{-C}_{24}$ alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds;



wherein R^5 and R^7 , same or different, are a C_3 - C_{24} hydrocarbon chain, straight chain or branched, either saturated or having 1 to 6 carbon-to-carbon double bonds;

R^6 and R^8 , same or different, are C_3 - C_{24} alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds; and

R^{10} and R^{11} , same or different, are a C_3 - C_{24} , saturated hydrocarbon chain, straight chain or branched; or an unsaturated C_3 - C_{24} , hydrocarbon chain, straight chain or branched, having 1 to 6, carbon-to-carbon double bonds;

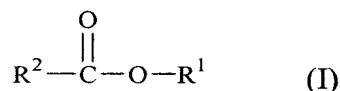


wherein R^{12} , R^{14} and R^{18} , same or different, are a C_3 - C_{24} , hydrocarbon chain, straight chain or branched, either saturated or having 1 to 6 carbon-to-carbon double bonds;

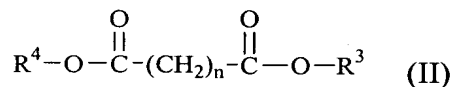
R^{13} , R^{15} and R^{19} , same or different, are a C_3 - C_{24} alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds; and

R^{16} , R^{17} and R^{20} , same or different, are a C_3 - C_{24} saturated hydrocarbon chain, straight chain or branched; or unsaturated C_3 - C_{24} hydrocarbon chain, straight chain or branched, containing 1 to 6 carbon-to-carbon double bonds.

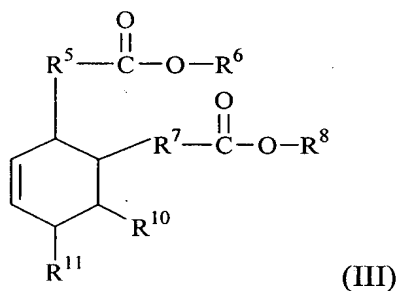
2. The rubber composition in accordance with claim 1, wherein the ester is selected from the group consisting of formula I, II, III, IV, and a combination of any two or more of said esters:



wherein R^1 is a C_3 - C_{18} alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds; and R^2 is a C_8 - C_{18} saturated fatty acid residue, or an unsaturated fatty acid residue having 1 to 3 carbon-to-carbon double bonds;



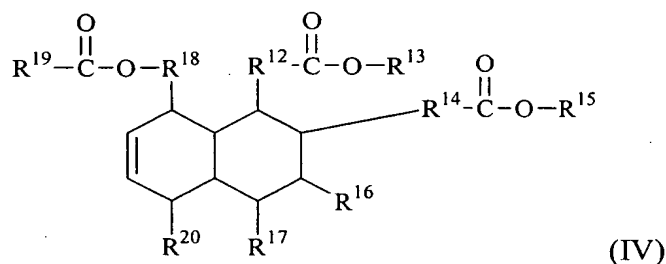
wherein $n=6-18$, and R^3 and R^4 , same or different, are a C_3 - C_{18} alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds;



wherein R^5 and R^7 , are a C_6 - C_{24} hydrocarbon chain, straight chain or branched; either saturated or having 1 to 3 carbon-to-carbon double bonds;

R^6 and R^8 , same or different, are a C_3 - C_{18} alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds; and

R^{10} and R^{11} , same or different, are a C_3 - C_{18} , saturated hydrocarbon chain, straight chain or branched; or an unsaturated hydrocarbon chain, straight chain or branched, containing 1 to 3 carbon-to-carbon double bonds;



wherein R^{12} , R^{14} and R^{18} , same or different, are a C_8 - C_{18} , hydrocarbon chain, straight chain or branched, either saturated or having 1 to 3 carbon-to-carbon double bonds;

R^{13} , R^{15} and R^{19} , same or different, are a C_6 - C_{18} alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds; and

R^{16} , R^{17} and R^{20} , same or different, are a C_6 - C_{18} saturated hydrocarbon chain, straight chain or branched; or an unsaturated C_6 - C_{18} hydrocarbon-chain, straight chain or branched, containing 1 to 3 carbon-to-carbon double bonds; and wherein

said reactive diluent is a monomer selected from the group consisting of (1) a glycidyl ether; (2) a diglycidyl ether; (3) an aliphatic, straight chain epoxide; (4) an epoxidized vegetable oil; (5) a cycloaliphatic epoxy; (6) a glycidyl ester; (7) a diglycidyl ester; and any combination thereof, present in the composition in an amount of about 5% to about 40% by weight, based on the total weight of adhesive resin plus ester of formula I - IV.

3. The rubber composition of claim 1, wherein the adhesive resin is a condensation product of a methylene acceptor and a methylene donor.

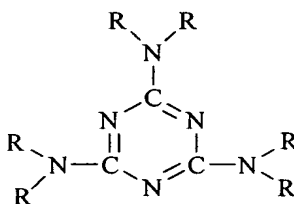
4. The rubber composition in accordance with claim 3, wherein the adhesive resin is selected from the group consisting of phenol-formaldehyde, melamine-formaldehyde; naphthol-formaldehyde; polyepoxide; a reaction product of triallyl cyanurate, resorcinol, and formaldehyde; a reaction product of p-chlorophenol, resorcinol, and formaldehyde; a copolymer of styrene, butadiene, and 2-vinylpyridine; and mixtures thereof.

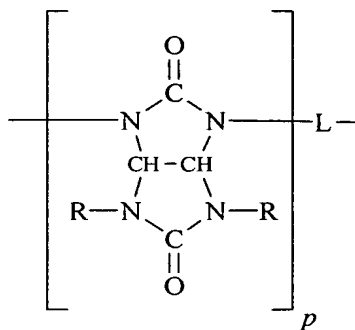
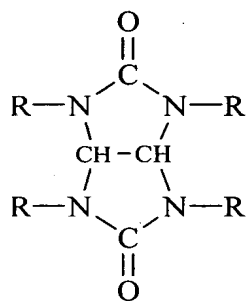
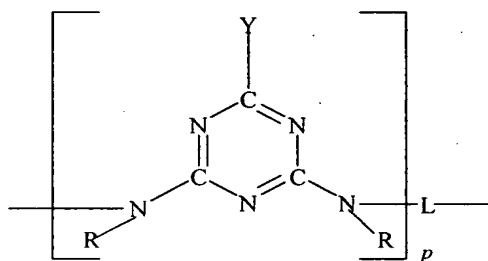
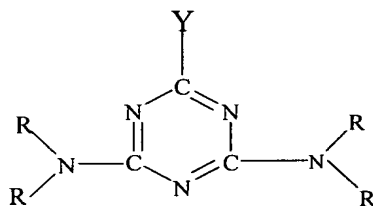
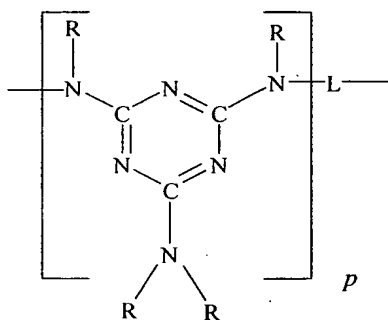
5. The rubber composition in accordance with claim 4, wherein the phenol-formaldehyde resin is resorcinol-formaldehyde.

6. The rubber composition in accordance with claim 1, wherein the adhesive resin is selected from the group consisting of derivatives of melamine, acetoguanamine, benzoguanamine, cyclohexylguanamine and glycoluril monomers and oligomers of these monomers, which have been substituted on average at two or more positions on the monomer or on each unit of the oligomer with vinyl terminated radicals, the rubber composition being free of resorcinol.

7. The rubber composition in accordance with claim 6, wherein at least one of the adhesive resins has been further substituted on average at one or more positions with a radical which comprises carbamoylmethyl or amidomethyl.

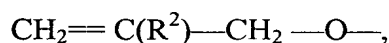
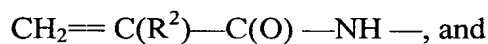
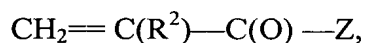
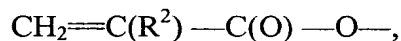
8. The rubber composition in accordance with claim 6, wherein the adhesive resin is selected from compounds of the formula:



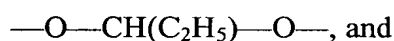
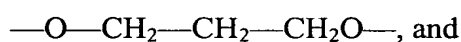
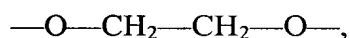


and positional isomers thereof,

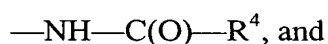
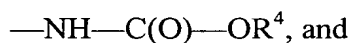
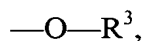
wherein, in each monomer and in each polymerized unit of the oligomers, Y is selected from methyl, phenyl and cyclohexyl, and, on average, at least two R are $-\text{CH}_2-\text{R}^1$, and any remaining R are H, and at least 2 R^1 are radicals selected from



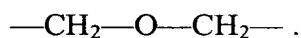
wherein R^2 is hydrogen or $\text{C}_1\text{-C}_{18}$ alkyl, and Z is a radical selected from



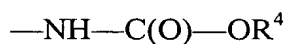
any remaining R^1 radicals are selected from



wherein R_3 is hydrogen or R_4 , and R_4 is a $\text{C}_1\text{-C}_{18}$ alkyl, alicyclic, hydroxyalkyl, alkoxyalkyl or aromatic radical, and in the oligomers, P is 2 to about 10, and L is methylene or the radical

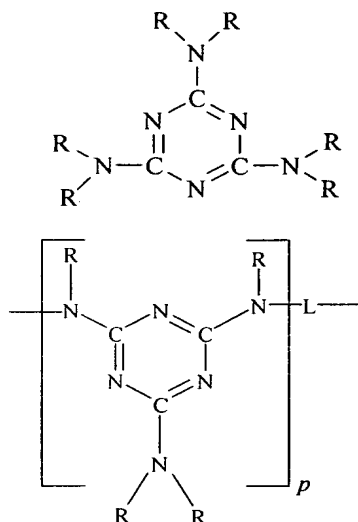


9. The rubber composition in accordance with claim 8, wherein on average at least one R^1 in each monomer or in each oligomerized unit of the adhesive resin is:



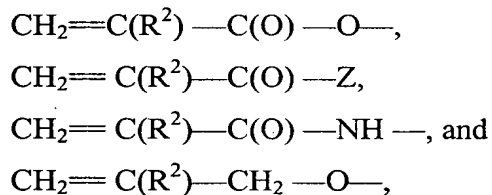
wherein R^4 is as defined in claim 8.

10. The rubber composition in accordance with claim 9, wherein the adhesive resin is a compound of the formula

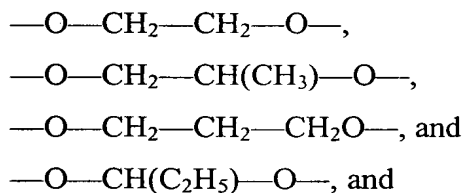


wherein P is 2 to about 10, L is methylene or the radical $-\text{CH}_2-\text{O}-\text{CH}_2-$, and R is as follows:

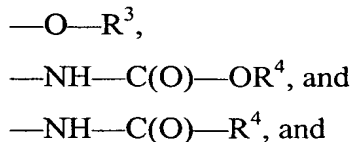
at least two R are $-\text{CH}_2-\text{R}^1$, and any remaining R are H, and at least 2 R^1 are radicals selected from



wherein R^2 is hydrogen or C_1 - C_{18} alkyl, and Z is a radical selected from

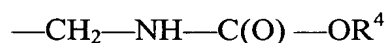


any remaining R^1 radicals are selected from



wherein R_3 is hydrogen or R_4 , and R_4 is a C_1 - C_{18} alkyl, alicyclic, hydroxyalkyl, alkoxyalkyl or aromatic radical.

11. The rubber composition in accordance with claim 10, wherein in the adhesive resin formulas, on average at least one R radical in each monomer or in each oligomerized unit is

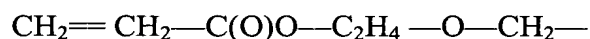


wherein R^4 is a $\text{C}_1\text{-C}_{18}$ alkyl, alicyclic, hydroxyalkyl, alkoxyalkyl or aromatic radical.

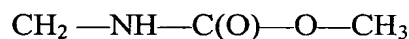
12. The rubber composition in accordance with claim 10, wherein on average at least two R radicals are selected from



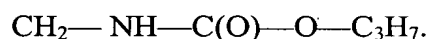
and



and at least one R radical is selected from



and



13. The rubber composition in accordance with claim 8, further comprising an additional additive selected from hydroxymethylated and alkoxyethylated (alkoxy having 1-5 carbon atoms) derivatives of melamine, acetoguanamine, benzoguanamine, cyclohexylguanamine and glycoluril and their oligomers.

14. The rubber composition in accordance with claim 6, wherein the adhesive resin is a derivative of melamine or an oligomer of melamine.

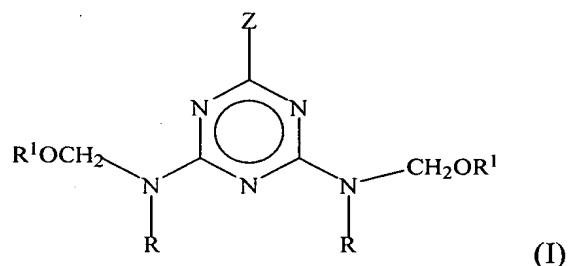
15. The rubber composition in accordance with claim 6, wherein the adhesive resin is a derivative of acetoguanamine or an oligomer of acetoguanamine.

16. The rubber composition in accordance with claim 6, wherein the adhesive resin is a derivative of benzoguanamine or an oligomer of benzoguanamine.

17. The rubber composition in accordance with claim 6, wherein the adhesive resin is a derivative of cyclohexylguanamine or an oligomer of cyclohexylguanamine.

18. The rubber composition in accordance with claim 1, wherein the adhesive resin is a self-condensing alkylated triazine resin selected from the group consisting of (i), (ii), and (iii):

(i) a self-condensing alkylated triazine resin having at least one of imino or methylol functionality and represented by formula (I)



(ii) an oligomer of (i), or

(iii) a mixture of (i) and (ii), wherein

Z is -N(R)(CH₂OR¹), aryl having 6 to 10 carbon atoms, alkyl having 1 to 20 carbon atoms or an acetyl group,

each R is independently hydrogen or -CH₂OR¹, and

each R^1 is independently hydrogen or an alkyl group having 1 to 12 carbon atoms,

provided that at least one R is hydrogen or $-CH_2OH$ and at least one R^1 is selected from the alkyl group; and

wherein the rubber composition is substantially free of methylene acceptor coreactants.

19. The rubber composition in accordance with claim 18, wherein at least one R group of the alkylated triazone resin is hydrogen.

20. The rubber composition in accordance with claim 19, wherein at least one R^1 group of the alkylated triazone resin is a lower alkyl group having 1 to 6 carbon atoms.

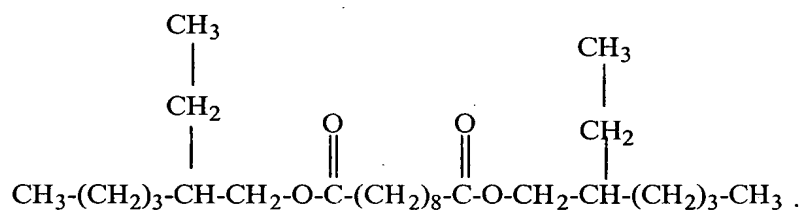
21. The rubber composition in accordance with claim 20, wherein the adhesive resin is a derivative of melamine, benzoguanamine, cyclohexylguanamine, or acetoguanamine, or an oligomer thereof.

22. The rubber composition in accordance with claim 20, wherein Z is $-N(R)(CH_2OR^1)$.

23. The rubber composition in accordance with claim 4, wherein the phenol-formaldehyde resin is resorcinol-formaldehyde; and the melamine-formaldehyde resin is N-(substituted oxymethyl) melamine-formaldehyde.

24. The rubber composition in accordance with claim 1, wherein the ester has the formula II and comprises a saturated diester formed by the reaction of sebacic acid and a C₆-C₂₄ alcohol, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds.

25. The rubber composition in accordance with claim 24, wherein the alcohol is 2-ethylhexyl alcohol, and the ester has the following formula:



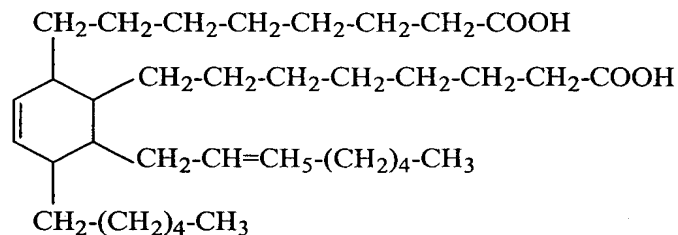
26. The rubber composition in accordance with claim 1, wherein the ester is an unsaturated diester formed by the reaction of a C₃₆ dimer acid and a C₃-C₁₈ alcohol, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds.

27. The rubber composition in accordance with claim 26, wherein the alcohol is 2-ethylhexyl alcohol.

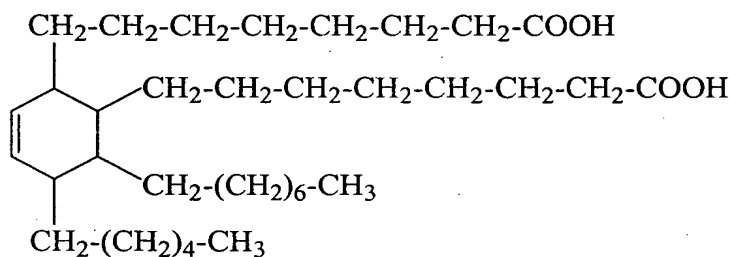
28. The rubber composition in accordance with claim 26, wherein the alcohol is tridecyl alcohol.

29. The rubber composition in accordance with claim 26, wherein the alcohol is oleyl alcohol.

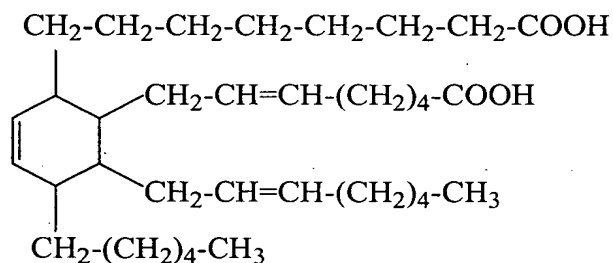
30. The rubber composition in accordance with claim 1, wherein the ester comprises the following dimer acid reacted with a C₃-C₂₄ alcohol:



31. The rubber composition in accordance with claim 1, wherein the ester comprises the following dimer acid reacted with a C₃-C₂₄ alcohol:



32. The rubber composition in accordance with claim 1, wherein the ester comprises the following dimer acid reacted with a C₃-C₂₄ alcohol:



$$\begin{array}{c}
 \text{HOOC-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-} \\
 \text{CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-COOH} \\
 \text{CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-COOH} \\
 \text{CH}_2\text{-CH=CH-(CH}_2\text{)}_4\text{-CH}_3 \\
 \text{CH}_3\text{-(CH}_2\text{)}_4\text{-CH}_2\text{ } \text{CH}_2\text{-(CH}_2\text{)}_4\text{-CH}_3
 \end{array}$$

35. The rubber composition in accordance with claim 34, wherein the ester is a reaction product of a C₃-C₂₄ alcohol straight chain or branched, saturated, or unsaturated having 1 to 3 carbon-to-carbon double bonds, with a dimer acid having CAS #61788-89-4.

37. The rubber composition in accordance with claim 35, wherein the alcohol is a tridecyl alcohol.

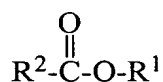
38. The rubber composition in accordance with claim 35, wherein the alcohol is an oleyl alcohol.

39. The rubber composition in accordance with claim 1, wherein the R^2 , R^5 , R^7 , R^{12} , R^{14} are fatty acid residues derived from animal or vegetable fatty acids.

40. The rubber composition of claim 39, wherein the fatty acids are selected from the group consisting of butter; lard; tallow; grease; herring; menhaden; pilchard; sardine; babassu; castor; coconut; corn; cottonseed; jojoba; linseed; oiticia; olive; palm; palm kernel; peanut; rapeseed; safflower; soya; sunflower; tall; tung; and mixtures thereof.

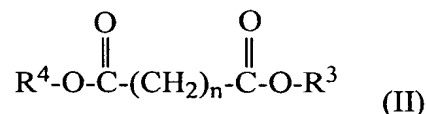
41. The rubber composition of claim 40, wherein the fatty acid residues are selected from the group consisting of hexanoic; octanoic; decanoic; dodecanoic; 9-dodecenoic; tetradecanoic; 9-tetradecenoic; hexadecanoic; 9-hexadecenoic; octadecanoic; 9-octadecenoic; 12-hydroxy; 9, 12-octadecadienoic; 9, 12, 15-octadecatrienoic; 9, 11, 13-octadecatrienoic; 9, 11, 13-octadecatrienoic, 4-oxo; octadecatetrenoic; eicosanoic; 11-eicosenoic; eicosadienoic; eicosatrienoic; 5, 8, 11, 14-eicosatetraenoic; eicosapentaenoic; docosanoic; 13-docosenoic; docosatetraenoic; 4, 8, 12, 15, 19-docosapentaenoic; docosahexaenoic; tetracosenoic; and 4, 8, 12, 15, 18, 21-tetracosahexaenoic.

42. A method of increasing the adhesion of a rubber composition to a substrate, said rubber composition including a natural or synthetic rubber; a vulcanizing agent for said rubber; and an adhesive resin, comprising adding a reactive diluent to said rubber composition, in an amount of about 0.5% to about 50% by weight, based on the total weight of the adhesive resin plus ester of formula I - IV, and about 0.1% to about 15% by weight, based on the weight of the rubber, of a liquid ester additive of formula I, II, III, IV, or mixtures thereof:

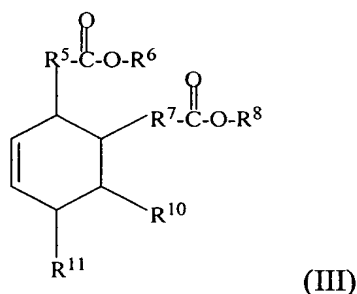


(I)

wherein R^1 is a C_3 - C_{24} alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds; R^2 is a C_3 - C_{24} saturated fatty acid residue, or an unsaturated fatty acid residue having 1 to 6 carbon-to-carbon double bonds;



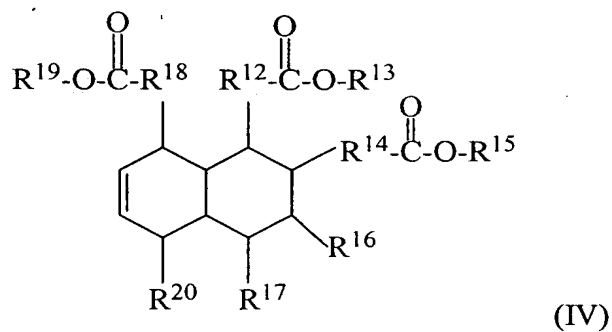
wherein $n=3-24$ and R^3 and R^4 , same or different, are a C_3 - C_{24} alkyl radical, straight chain or branched;



wherein R^5 and R^7 , same or different, are a C_3 - C_{24} hydro carbon chain, straight chain or branched, either saturated or having 1 to 6 carbon-to-carbon double bonds;

R^6 and R^8 , same or different, are a C_3 - C_{24} alkyl radical, straight chain or branched; and

R^{10} and R^{11} , same or different, are a C_3 - C_{24} , saturated hydrocarbon chain, straight chain or branched; or an unsaturated C_3 - C_{24} , hydrocarbon chain, straight chain or branched, having 1 to 6 carbon-to-carbon double bonds;



wherein R^{12} , R^{14} and R^{18} , same or different, are a C_3 - C_{24} hydrocarbon chain, straight chain or branched, either saturated or having 1 to 6 carbon-to-carbon double bonds;

R^{13} , R^{15} and R^{19} , same or different, are C_3 - C_{24} alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds; and

R^{16} , R^{17} and R^{20} , same or different, are C_3 - C_{24} saturated hydrocarbon chain, straight chain or branched; or unsaturated C_3 - C_{24} hydrocarbon chain, straight chain or branched, containing 1 to 6 carbon-to-carbon double bonds; and

comprising subjecting the composition to conditions sufficient to vulcanize the rubber in said composition, such that the reactive diluent strengthens the adherence between the rubber and the substrate.

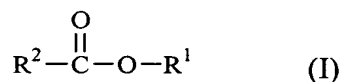
43. The method in accordance with claim 42, wherein the substrate is a plurality of cords, and the reactive diluent is a monomer selected from the group consisting of (1) a glycidyl ether; (2) a diglycidyl ether; (3) an aliphatic, straight chain epoxide; (4) an epoxidized vegetable oil; (5) a cycloaliphatic epoxy; (6) a glycidyl ester; (7) a diglycidyl ester; and any combination thereof, present in the composition in an amount of about 5% to about 40% by weight, based on the total weight of adhesive resin plus ester of formula I - IV.

44. The method in accordance with claim 42, wherein the substrate is a polymeric sheet or fabric, and the reactive diluent is a monomer selected from the group consisting of (1) a glycidyl ether; (2) a diglycidyl ether; (3) an aliphatic, straight chain epoxide; (4) an epoxidized vegetable oil; (5) a cycloaliphatic epoxy; (6) a glycidyl ester; (7) a diglycidyl ester; and any combination thereof, present in the composition in an amount of about 5% to about 40% by weight, based on the total weight of adhesive resin plus ester of formula I - IV.

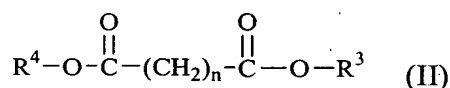
45. The method in accordance with claim 42, wherein the substrate is flat metal stock material, and the reactive diluent is a monomer selected from the group consisting of (1) a glycidyl ether; (2) a diglycidyl ether; (3) an aliphatic, straight chain epoxide; (4) an epoxidized vegetable oil; (5) a cycloaliphatic epoxy; (6) a glycidyl ester; (7) a diglycidyl ester; and any combination thereof, present in the composition in an amount of about 5% to about 40% by weight, based on the total weight of adhesive resin plus ester of formula I - IV.

46. A method of increasing the adhesion of a rubber composition, containing a vulcanizing agent for the rubber, to a substrate comprising an expedient selected from the group consisting of (1) applying a liquid adhesion promoter comprising an adhesive resin component, a reactive diluent component, and an ester component to the substrate prior to contacting the substrate with the rubber composition; (2) contacting the substrate separately with a solvent solution containing a reactive diluent or water-based emulsion containing the ester component and the reactive diluent component of the liquid adhesion promoter, and contacting the substrate separately with a solvent solution containing a reactive diluent, or water-based emulsion containing the adhesive resin component and the reactive diluent component of the liquid adhesion promoter prior to contacting the substrate with the rubber composition; (3) applying the adhesive resin component and the reactive diluent component of the liquid adhesion promoter to the substrate prior to contacting the adhesive resin-applied substrate with the rubber composition containing a solvent solution or water-based emulsion

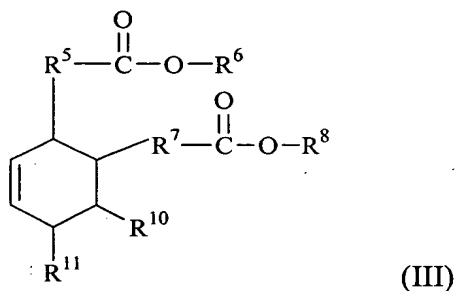
containing the ester component of the liquid adhesion promoter; (4) applying the ester component of the liquid adhesion promoter to the substrate prior to contacting the ester-applied substrate with the rubber composition containing a solvent solution or water-based emulsion containing the adhesive resin component and the reactive diluent component of the liquid adhesion promoter; wherein the ester component of the adhesion promoter is selected from the group consisting of formulas I, II, III, IV, and a combination of any two or more:



wherein R^1 is a $\text{C}_3\text{-C}_{24}$ alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds; R^2 is a $\text{C}_3\text{-C}_{24}$ saturated fatty acid residue, or an unsaturated fatty acid residue having 1 to 6 carbon-to-carbon double bonds;



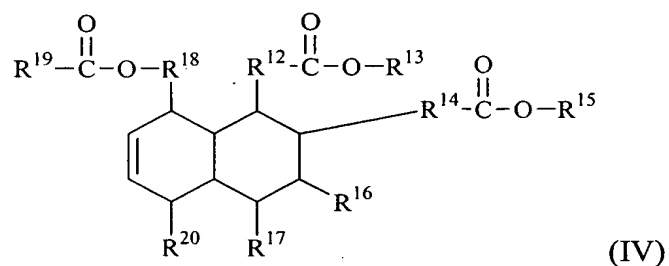
wherein $n=3\text{-}24$, and R^3 and R^4 , same or different, are a $\text{C}_3\text{-C}_{24}$ alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds;



wherein R^5 and R^7 , same or different, are a $\text{C}_3\text{-C}_{24}$ hydrocarbon chain, straight chain or branched, either saturated or having 1 to 6 carbon-to-carbon double bonds;

R^6 and R^8 , same or different, are $\text{C}_3\text{-C}_{24}$ alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds; and

R^{10} and R^{11} , same or different, are a $\text{C}_3\text{-C}_{24}$, saturated hydrocarbon chain, straight chain or branched; or an unsaturated $\text{C}_3\text{-C}_{24}$, hydrocarbon chain, straight chain or branched, having 1 to 6, carbon-to-carbon double bonds;



wherein R^{12} , R^{14} and R^{18} , same or different, are a C_3 - C_{24} , hydrocarbon chain, straight chain or branched, either saturated or having 1 to 6 carbon-to-carbon double bonds;

R^{13} , R^{15} and R^{19} , same or different, are a C_3 - C_{24} alkyl radical, straight chain or branched, saturated, or unsaturated containing 1 to 3 carbon-to-carbon double bonds; and

R^{16} , R^{17} and R^{20} , same or different, are a C_3 - C_{24} saturated hydrocarbon chain, straight chain or branched; or unsaturated C_3 - C_{24} hydrocarbon chain, straight chain or branched, containing 1 to 6 carbon-to-carbon double bonds; and

comprising subjecting the composition to conditions sufficient to vulcanize the rubber in said composition, such that the reactive diluent strengthens the adherence between the rubber and the substrate.

47. The method in accordance with claim 46, wherein the amount of the adhesive resin component contained in the rubber composition or applied to the substrate is about 0.1% to about 15% by weight, based on the weight of rubber in the composition, the amount of ester component contained in the rubber composition or applied to the substrate is about 0.1% to about 15% by weight, based on the weight of rubber in the composition, and the amount of the reactive diluent component contained in the rubber composition or applied to the substrate is about 0.5% to about 50% by weight, based on the total weight of the adhesive resin component plus ester component.

48. A cord-reinforced article of manufacture comprising a plurality of cords selected from polymeric cords, metal cords, glass cords, and a combination thereof, adhered to the rubber composition of claim 1.